FIELD EFFECT-CONTROLLABLE SEMICONDUCTOR COMPONENT

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation of copending international application PCT/DE97/00528, filed Mar. 14, 1997, which designated the United States.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention lies in the semiconductor electronics field. More specifically, the invention relates to a field effect-controllable semiconductor component with a drain zone of the first conductivity type, at least one gate electrode composed of polycrystalline silicon and insulated from the drain zone, and at least one source region of the second conductivity type introduced in the drain zone.

A field effect-controllable semiconductor component of this type is a vertical MOS field-effect transistor, for example. Those transistors have been known for a long time. A description may be found, for example, in Siemens Datenbuch 1993–94 SIPMOS-Halbleiter, Leistungstransistoren und Dioden [Siemens Data Book 1993–94 SIPMOS Semiconductors, Power Transistors and Diodes], page 29 ff. FIG. 4 on page 30 of the Data Book shows the fundamental structure of such a power transistor. There, the n^+-type substrate serves as carrier with the underlying drain metallization layer. The n^+-type substrate is adjoined above it by an n^--type epitaxial layer, which has a different thickness depending on the reverse voltage and is correspondingly doped. The superior gate made of n^+-type polysilicon is embedded in insulating silicon dioxide and serves as an implantation mask for the p-type well and for the n^+-type source zone. The source metallization layer covers the entire structure and connects the individual transistor cells of the chip in parallel. Further details can be found on page 30 ff. of the Data Book.

The disadvantage of a configuration of that type is that the forward resistance R_{on} of the drain-source load path increases as the dielectric strength of the semiconductor component increases, since the thickness of the epitaxial layer must increase. At 50 V, the forward resistance R_{on} per unit area is approximately 0.20 Ωmm^2 and rises at a reverse voltage of 1000 V to a value of approximately 10 Ωmm^2, for example.

In order to solve this problem, the IGBT was developed, which mixes MOS and bipolar functions in order to be turned on better. Such a transistor is slower than a MOSFET, however.

It is know in lateral field-effect transistors, to design the gate in such a way that it rises in step-like or linear fashion, for example, in the direction toward the drain electrode. The breakdown voltage increases with an increasing distance between the gate electrode and the channel region. The saturation voltage increases as well. A cascade circuit of a plurality of field-effect transistors with increasing breakdown voltages and lower saturation voltages is realized, in principle, by a structure of this type. However, lateral transistors require a large area.

U.S. Pat. No. 5,216,275 to Chen discloses a semiconductor component in which the drain layer applied to the substrate comprises vertical alternately p-doped and n-doped layers. The prior patent shows those layers in FIG. 4 of the description, for example. The p-type layers are

designated by **7** and the n-type type layer by **6**. The description, in particular column **2**, line **8**, reveals that the alternate p-type and n-type layers must each be connected to the p^+-type and the p^--type region, respectively. However, this leads to a severe restriction in the design of a semiconductor component since the edge regions can no longer be freely configured.

My earlier U.S. Pat. No. 5,438,215 discloses a power MOSFET which has a high blocking capability and a reduced forward resistance. However, such a component is difficult to fabricate.

SUMMARY OF THE INVENTION

It is accordingly an object of the invention to provide a field effect-controllable semiconductor component which overcomes the above-mentioned disadvantages of the heretofore-known devices and methods of this general type and which provides a low forward resistance in spite of a high reverse voltage.

With the foregoing and other objects in view there is provided, in accordance with the invention, a field effect-controllable semiconductor component, comprising:

a semiconductor body having a surface;

a drain zone of a first conductivity type in the semiconductor body;

a gate electrode composed of polycrystalline silicon in the semiconductor body, the gate electrode being insulated from the drain zone;

a source region of a second conductivity type introduced in the drain zone;

the drain zone having a trench structure formed therein reaching from the surface of the semiconductor body into the drain zone; and

a field plate in the trench structure and an oxide layer surrounding the field plate, the oxide layer having a thickness increasing in a direction towards the drain zone.

In accordance with an added feature of the invention, a further layer surrounds the oxide layer and the further layer is doped more heavily with the first conductivity type than the drain zone.

In accordance with an additional feature of the invention, at least one additional layer of the second conductivity type is introduced into the oxide layer surrounding the field plate.

In accordance with another feature of the invention, the trench structure is one of a multiplicity of trench structures arranged in grid or strip form in the semiconductor body.

In accordance with a further feature of the invention, the field plate is electrically connected to a source terminal of the source region.

In accordance with again a further feature of the invention, the field plate is electrically connected to the gate electrode.

In accordance with again another feature of the invention, the field plate is a vertical field plate serving as a gate.

In accordance with a concomitant feature of the invention, the field plate is composed of polysilicon.

The advantage of the present invention is that the previously mentioned advantages of a lateral field-effect transistor can also be utilized according to the invention in a vertical field-effect transistor, in that the gate or an insulated additional field plate electrode which is introduced into the substrate in the vertical direction has, with increasing depth, an increasing distance from the surrounding insulating gate oxide.